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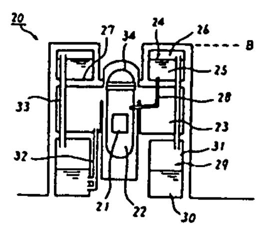
90-175453/23 K05 X14 **TOKE 26.10.88** TOSHIBA KK *J0 2115-793-A 26.10.88-JP-268069 *(27.04.90)* G21c-09 G21c-13 G21c-15/18 **Reactor container to prevent pressure rise during accident - has pressure vessel for core, dry well encircling core and upper pool outside** **C90-076452**	K(5-B1)

Container comprises pressure vessel accommodating the core, dry well encircling the core, upper pool arranged at outside of the dry well and at the higher position than the core and has water at lower part and a space at upper part, emergency core-cooling line piping connecting the upper pool lower part and the pressure vessel, pressure suppression chamber arranged below the dry well having water at lower part and a space at upper part, vent pipe connecting the lower part of the suppression chamber and the dry well and connecting pipe connecting the space of the suppression chamber and the pool space.

USE/ADVANTAGE - The pressure suppression chamber and the upper pool are divided to upper and lower parts, which achieves stable construction. At the time of breakage accident of the prim. line, the steam discharged to the dry well is introduced into the water in the suppression chamber through vent, pipe and pressure rise is prevented and non-condensation gas is lead to the space which prevents a pressure rise effectively. (6pp Dwg.No.1/5)



第 1 図

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JAPAN, KOKAI
2-115793

A Reactor Containment System
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Specification /545[1]

1. Title of the Invention: A Reactor Containment System

2. Claims:

(1) A reactor containment system characteristically consisting of a reactor pressure vessel containing the reactor core, a dry well enclosing the reactor pressure vessel, an upper pool which is positioned outside of the dry well and higher than the reactor core and which reserves water at the bottom and has a space above, an emergency reactor core cooling system pipe connecting between the bottom of the upper pool and the aforementioned reactor pressure vessel, a suppression chamber which is positioned at the lower section of the aforementioned dry well and which reserves water at the bottom and has a space above, a vent pipe connecting between the lower part of the suppression chamber and the aforementioned dry well, and a connecting pipe connecting the space in the aforementioned suppression chamber and the space in the aforementioned upper pool.

(2) The reactor containment system as claimed in Item (1) in which the terminal opening of the aforementioned vent pipe at the side of the aforementioned dry well is set at a

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1 Numbers in margins indicate pagination in the foreign text.

position higher than the dry well overhead flooding level at the time of an accident.

(3) The reactor containment system as claimed in Item (1) in which a dry well spray is installed, having one end connected to the lower part of the aforementioned upper pool and the other hand connected to the upper part of the aforementioned dry well.

3. Detailed Description of the Invention

(Purpose of the Invention)

(Industrial Field of Application)

This invention concerns a reactor containment system containing a reactor pressure vessel which is installed at a nuclear power station.

(Prior Art)

A reactor pressure vessel containing the reactor core having fuel is contained in the dry well of the reactor containment system. One of the assumed accidents in the dry well is breakdown an accident of the primary system piping. Vapor and water which are discharged into the dry well enclosing the reactor pressure vessel are introduced via the vent pipe into the suppression chamber pool water. Vapor is condensed in this water by cooling to absorb energy and the pressure increase in the dry well is suppressed. /546

In the case of such an accident, a cooling material overflows out of the reactor pressure vessel to expose the reactor core, which may cause burning of the reactor core. For

this reason, emergency reactor core cooling equipment which injects a cooling water from other passages to the reactor pressure vessel in order to prevent burning of the reactor core. A power source such as a pump is used for injecting the cooling water from the emergency reactor core cooling equipment into the reactor pressure vessel. On the other hand, instead of depending on a power source, Japanese Patent No. 38-16198 discloses the concept of a reactor containment having emergency reactor core cooling equipment for injection of cooling water using gravity.

This reactor containment will be explained using Figure 10. A reactor containment 1 consists of a dry well 3 containing a reactor pressure vessel 2 and a suppression chamber 4. Water is reserved at the lower portion 5 of the suppression chamber 4 and a vent pipe 6 connects between the water and the dry well 3. The bottom 7 of the suppression chamber 4 is located at a position higher than the reactor core 8. The suppression chamber 4 and the reactor pressure vessel 2 are connected via a valve 9 by a reactor core cooling piping 10.

If an accidental breakdown occurs at the primary piping in this type of reactor containment, vapor discharged into the dry well 3 is introduced into the water via the vent pipe 6 and the pressure increase in the dry well 3 is suppressed by condensation by cooling.

The water reserved in the suppression chamber 4 is used as emergency reactor core cooling water as well. If a cooling material overflows from the reactor pressure vessel 2, the

cooling water is introduced into the reactor pressure vessel 2 by opening the valve 9 of the reactor core cooling piping 10 in order to prevent burning of the reactor core 8. Since the bottom 7 of the suppression chamber 4 is set higher than the reactor core 8, the cooling water is introduced simply by opening the valve 9 due to gravity so that a power source is not needed. This means that there is no need to consider a power source failure.

(Subjects That This Invention Intends to Solve)

However, the water stored in the suppression chamber 4 must satisfy both the amount to condense vapor discharged from the dry well 3 at the time of an accident, and the amount to inject into the reactor pressure vessel 2 as the cooling water for the emergency reactor core cooling equipment. Thus, it will be a very large amount. Therefore, since the reactor containment 1 has a large weight at the upper portion, the structure is unstable due to a high center of gravity. The earthquake load caused by the acceleration rate at the time of an earthquake becomes heavy, causing a problem with safety. In order to resist this, the body of the reactor containment 1 and the basic portion of the reactor housing must have a firm structure.

On the other hand, work such as input and output of fuel from the upper lid 11 of the reactor pressure vessel 2 is performed at the time of periodic inspection of the nuclear power plant and the suppression chamber 4 is used as a work area for this. However, entering the suppression chamber 4 has many

restrictions in terms of radiation contamination so that this causes an environmental problem.

In order to secure water in the suppression chamber by lowering the height of the working floor level A, the diameter of the reactor containment 1 must be large. However, if the diameter is enlarged, this will be disadvantageous to the pressure at the time of an accident. In order to secure the equivalent pressure resistance function, the plate thickness of the reactor vessel must be thicker.

The purpose of this invention is to provide a highly reliable reactor containment demonstrating excellent structural strength by overcoming the problem with an unstable structure due to a high center of gravity.

[Constitution of the Invention]

(Means to Solve the Subjects Concerned)

To achieve the purpose of this invention mentioned above, this invention provides a reactor containment system characteristically consisting of a reactor pressure vessel containing the reactor core, a dry well enclosing the reactor pressure vessel, an upper pool which is positioned outside of the dry well and higher than the reactor core and which reserves water at the bottom and has a space above, an emergency reactor core cooling system pipe connecting the bottom of the upper pool to the aforementioned reactor pressure vessel, a suppression chamber which is positioned at the lower section of the aforementioned dry well and which reserves water at the bottom

and has a space above, a vent pipe connecting between the lower part of the suppression chamber and the aforementioned dry well, and a connecting pipe connecting the space in the aforementioned suppression chamber and the space in the aforementioned upper pool.

(Action) /547

Since a suppression chamber is separated from the upper pool which is vertical emergency reactor core cooling equipment, the structure is stable due to the absence of segregation of the center of gravity.

On the other hand, vapor discharged into the dry well during an accident causing a rupture in the primary piping is introduced into the water from the vent pipe in the suppression chamber so that the pressure increase is suppressed by condensation by cooling. In this case, non-condensed gas is discharged into the space in the suppression chamber. Since the space in the suppression chamber is shared by the space in the upper part of the pool by a connecting pipe, the pressure of the aforementioned non-condensed gas is transmitted to the space of the upper portion of the pool so that the pressure is effectively inhibited. The pressure of the non-condensed gas which has been transmitted to the space of the upper portion pool by means of the aforementioned connecting pipe acts as a driving pressure when the upper pool water is injected to the reactor pressure vessel.

(Example)

Examples of this invention will be explained by referring to Figures 1 through 9.

Figure 1 is a longitudinal cross-sectional view showing the first example of this invention. A reactor containment system 20 is placed in a reactor housing which is not shown and has an almost cylindrical shape having a reactor pressure vessel as a core. The reactor pressure vessel 22 is encircled by a dry well 23 containing a reactor core 21. An upper pool 24 is made in a circular shape having a rectangular cross-section above the dry well 23. Emergency reactor core cooling water is stored at the lower part 25 of the upper pool 24. The upper portion of the cooling water forms a space 26. The bottom 27 of the upper pool 24 is located at a position higher than the reactor core 21, and the upper pool 24 and the reactor pressure vessel 22 are connected by an emergency reactor core cooling pipe 28 via a valve which is not shown. A suppression chamber 29 is installed at the lower part of the dry well 23. Water for suppression is stored at the lower part of 30 of this suppression chamber 29 and the upper part of the water forms a space 31. The lower part 30 of the suppression chamber 29 and the dry well 23 are connected by a vent pipe 32. The space 26 above the upper pool 24 and the space 31 above the suppression chamber 29 are connected by a connection pipe 33.

Since a suppression chamber 29 and an upper pool 24 are vertically separated in the reactor containment system 20 with

the structure mentioned above, a heavy weight is not loaded on the upper portion and the center of gravity can be kept low to have a stable structure. Since the diameter of the reactor containment system 20 can be reduced to be small, it is possible to shorten the duration of construction and building restrictions can be minimized. The working floor level B used for working during periodic checking is close to the upper lid 34 of the reactor pressure vessel 22 so that working efficiency is improved as well as for performing work outside of the reactor containment system 20.

In an accidental overflow of the cooling material in the reactor pressure vessel 22 due to rupture of the primary piping (not shown) connected to the reactor pressure vessel 22, a valve (not shown) installed at the emergency reactor core cooling pipe 28 opens and the emergency reactor core cooling water stored in the upper pool 24 is poured into the reactor pressure vessel 22 due to gravity. In this case, pressure such as vapor discharged into the dry well 23 during the aforementioned accident is transmitted to the upper pool 24 via the vent pipe 32 and the connection pipe 33, acting as a driving pressure for injection. Therefore, injection is secured more than the case with gravity alone. Since spaces 26 and 31 between the suppression chamber 29 and the upper pool 29 are shared, the pressure increase in the non-condensed gases discharged into the space 31 of the suppression chamber 29, which are not condensed by the water

stored in the suppression chamber 29, can be suppressed efficiently.

Figure 2 explains the second example of this invention. Figure 2 is a longitudinal cross-sectional view showing the second example. The reactor containment system 20a is set up in such a way that in the reactor containment system 20 of the first example, the emergency reactor core cooling water injected into the reactor pressure vessel 22 at the time of an accident overflows from the rupture hole of the pipe into the dry well 23 and the end of the vent pipe 39 at the dry well side 23 is higher than the flooding water level C of the emergency reactor cooling water. The flooding water level C is set up at a position higher than the reactor core 21 so that the reactor core 21 can always maintain a flooded state. The emergency reactor core cooling water overflowing to the dry well 23 can be prevented from entering the suppression chamber 29 via a vent pipe 39. Therefore, the water capacity of the upper pool 24 can be minimized.

Figure 3 is a longitudinal cross-sectional view showing the third example of this invention. /548

In the reactor containment system 20b, the reactor pressure vessel 22 is lowered so that the reactor core 21 in the reactor containment system 20 of the first example, is lower than the water surface of the water contained in the suppression chamber 29. As a result, radiation screening of the reactor core 21 can be done effectively using water.

Figure 4 is a longitudinal cross-sectional view showing the fourth example of this invention. In the reactor containment system 20c, the reactor pressure vessel 22 is lower so that the reactor core 21 becomes under the water surface of the suppression chamber 29 in the reactor containment system 20 in the first example and at the same time, a control rod driving system (not illustrated) is positioned at the upper part of the reactor pressure vessel 22. Therefore, radiation screening of the reactor core 21 can be performed effectively using water from the suppression chamber 29.

Figure 5 is a longitudinal cross-sectional view showing the fifth example of this invention. The reactor containment system 20d installs a dry well spray 34 which sprays water from the emergency reactor core cooling water stored in the upper pool 24, directly into the dry well 23, in the reactor containment system 20 of the first example. This dry well spray 34 consists of a pipe 35, one end of which is connected to the lower part 25 of the upper pool 24 and the other end of which is connected to the upper part of the dry well 23, a valve located in the middle of the pipe 35 (not shown), and a spray nozzle 36 positioned at the tip of the pipe 35 at the dry well side 23. If the emergency reactor core cooling water is sprayed by the dry well spray 34 at the time of accident into the dry well 23, pressure increase in the dry well 23 can be suppressed. A vacuum rupture valve 37 connecting the space 31 of the suppression chamber 29 and the dry well 23 is installed at the vent pipe 32d. When the pressure in

the dry well 23 declines below the specified level, non-condensed gas is introduced from the suppression chamber 29 to the dry well 23.

Figure 6 is a longitudinal cross-sectional view showing the third example of this invention. In the reactor containment system 20e, the height of the upper pool 24 is lowered and the diameter is increased in order to assure the specified capacity. The bottom 27e of the upper pool 24e is set up at a position lower than the upper level 38 of the dry well 23. Since the working floor level D becomes closer to the upper lid 34 of the reactor pressure vessel 22, the working efficiency can be further improved.

In the first through sixth examples, the upper pool and the suppression chamber are formed in a circular shape around the circumference of the dry well, but the shape is not limited in this invention. In addition, the shape of the reactor containment system is not limited to the cylindrical shape. For example, a fuel pool formed by partitioning a portion of the upper pool formed in a circular shape can be used. Alternatively, a single or numerous rectangular-shaped ones can be used.

Subsequently, Figure 7 explains the seventh example of this invention. In the reactor containment system 20f, a steel upper pool 24f is installed at the upper part of the dry well 23. Therefore, it is effective in shortening the duration of work.

The connection pipe 33f is connected through the external part of the dry well 23.

Figure 8 is a longitudinal cross-sectional view showing the eighth example of this invention. In the reactor containment system 20g, a steel upper pool 24g is formed and the dry well 23g forms a cone-shape having smaller upper surface 38 than the bottom surface 40 of the dry well 23g. For this reason, the dry well 23g becomes smaller so that the suppression chamber 29 has extra capacity.

Figure 9 is a longitudinal cross-sectional view showing the ninth example of this invention. In the reactor containment system 20h, a steel upper pool 24h is formed and the outer walls of the dry well 23h and the suppression chamber 29h are also made of steel. The outside is encircled by the biological screen wall 41 which is a part of the reactor housing.

The steel upper pool shown in the 7 through 9th examples has a circular shape, but it is not limited to this shape. Horizontal type tanks, standing type tanks, divided tanks and other types of tanks are applicable.

This invention is not limited to these examples explained above. In terms of shapes and materials of dry well, suppression chamber and upper pool, a variety of selections are possible or various combinations are possible.

[Effects of the Invention]

This invention provides a reactor containment system having a stable structure which exhibits excellent working efficiency

and reliability.

4. Brief Explanation of the Figures /549

Figure 1 through Figure 9 are longitudinal cross-sectional views showing the examples 1 through 9 of the reactor containment system of this invention. Figure 10 is a longitudinal cross-sectional view showing the conventional reactor containment system.

20, 20a, 20b, 20c, 20d, 20e, 20f, 20g, and 20h: Reactor containment systems

21: Reactor core

22: Reactor pressure vessel

23 and 23h: Dry wells

24, 24e, 24f, 24g, 24h: Upper pool

28: Emergency reactor core cooling system piping

29 and 29h: Suppression chamber

32, 32d, and 39: Vent pipe

33 and 33f: Connection pipes

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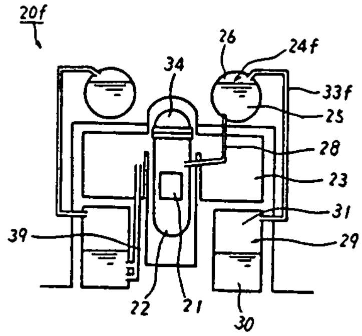

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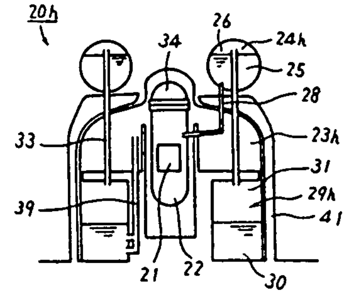

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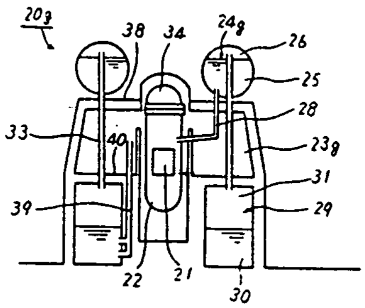

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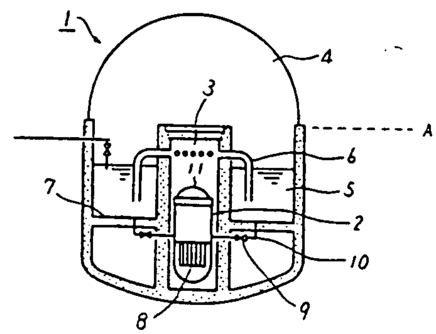

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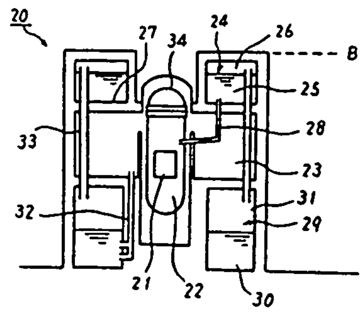

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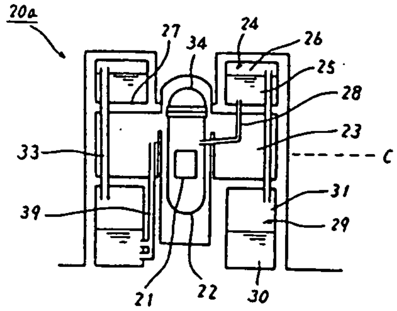

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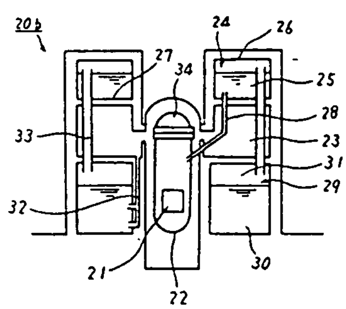

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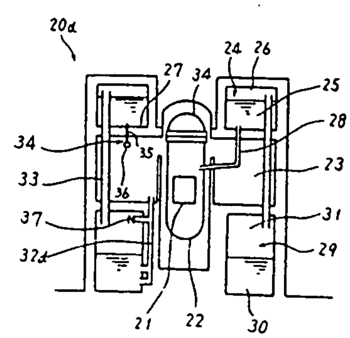

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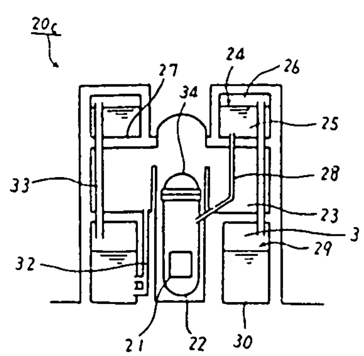

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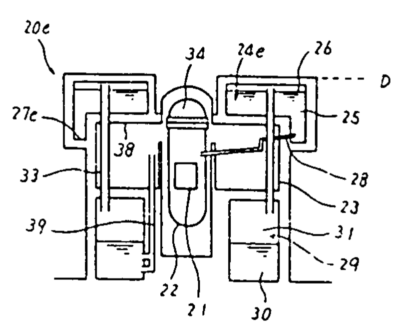

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